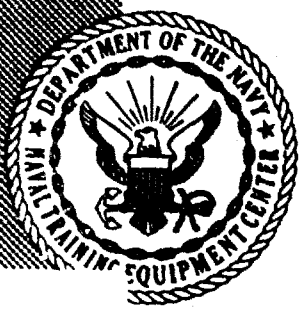

TECHNICAL REPORT: NAVTRAEQUIPCEN IH-284

MILITARY WEAPON SIMULATORS UTILIZING VISIBLE WAVELENGTH LASERS

Physical Sciences Laboratory
Naval Training Equipment Center
Orlando, Florida 32813

April 1977

Progress Report for Period 1967 - 1976

NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

Technical Report: NAVTRAEQUIPCEN IH-284

Military Weapon Simulators Utilizing Visible Wavelength Lasers

NEIL MOHON
Physical Sciences Laboratory

April 1977

Approved:

GEORGE DERDERIAN
Head, Physical Sciences Laboratory

JAMES F. HARVEY
Director
Research and Technology Department

NAVAL TRAINING EQUIPMENT CENTER

ORLANDO, FLORIDA 32813

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NAVTRAEQUIPC[redacted]H-284	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Military Weapon Simulators Utilizing Visible Wavelength Lasers.	5. TYPE OF REPORT & PERIOD COVERED: Progress Report, [redacted] 1967 — 1976,
	6. PERFORMING ORG. REPORT NUMBER: NAVTRAEQUIPCEN-IH-284
7. AUTHOR(s): Neil Mohon	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Physical Sciences Laboratory, N-211, Naval Training Equipment Center, Orlando, FL 32813	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NAVTRAEQUIPCEN Task 7715-1
11. CONTROLLING OFFICE NAME AND ADDRESS: Research & Technology Department, N-21, Naval Training Equipment Center, Orlando, FL 32813	12. REPORT DATE: Apr[redacted]77 / 13. NUMBER OF PAGES: 12 19p.
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This report was presented as a technical paper on 15 September 1976 at the International Electro-Optical Systems Design Conference which was held in New York, New York.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Simulator	Laser
Trainer	Weapon Simulator

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

One of the more interesting applications of the visible laser is that of weapon simulation for military training. The laser produces several characteristics in a simulator that make it ideal for the training situation, such as, safety, cost savings, and immediate scoring feedback. Several laser weapon simulators developed and patented by the Naval Training Equipment Center are discussed. The basic concept, test and evaluation, and the final end product

over

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

390462

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

are presented for: Tank Gunnery Trainer, Machine Gun Trainer, Howitzer Direct Fire Trainer, and Helicopter Door Gunnery Trainer.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION I

INTRODUCTION

The Naval Training Equipment Center, Orlando, Florida, has been involved in the application of visible lasers for simulating the firing of a weapon for about twelve years. Once the basic qualities of the laser had been defined, its usefulness and application in weapon simulation became apparent. The laser provided a safe training system for novice military personnel, including an immediate scoring feedback without the expense or danger of using live ammunition. A continual program has been in existence through the years and several trainers have gone into the field.

Four successful weapon firing simulators will be discussed which employ low power visible lasers as a means for hit indication. Personnel at the Naval Training Equipment Center performed the original research and development on these systems and hold the patents on them. The four trainers under consideration are: the Tank Gunnery Trainer, the Artillery Direct Fire Trainer, the Machine Gun Simulator, and the Helicopter Door Gunnery Trainer. The basic concept will be illustrated along with some test and evaluation results.

SECTION II

TANK GUNNERY TRAINER[1,2]

The purposes of the Tank Gunnery Trainer (Device M55) are to provide the novice tank gunner with the ability to see where the rounds from his main gun would have impacted had he in fact fired the weapon, and to give him experience in the feel of the hydraulic system by which he must manipulate his weapon. The trainee sits (see figure 1) inside an actual tank, on which the simulator has been mounted, in his usual position and views the target through his sights in a normal fashion. A stationary target board, having five target spots 15 centimeters in diameters, is placed at a 60 meter range in front of the tank. At this range we are teaching only direct fire of the main gun; and no ballistics are involved. In actual use, there are several tanks in a row equipped with Tank Gunnery Trainers which may be fired at a row of several targets at the 60 meter range.

The trainer is composed of (see figure 2) a laser head and an electronics package. The laser head houses a one milliwatt helium-neon laser the beam of which is passed through a reversed-type telescope system which projects the laser beam into a 15 millimeter spot at the target. The electronics package is operated from the 28 volt direct current power supply of the tank and actually turns the laser on and off with each trigger pull. The laser comes on when the trigger is depressed, remains on for 100 milliseconds, and then shuts off automatically. The recycle time is approximately 0.25 second. Because of the short burst of laser light, this trainer is in the Exempt Category of laser safety standard ANSI Z136.1-1976, and is eyesafe.

The target is covered with thousands of small glass beads to make the surface retroreflective. This surface provides a gain of 115 over a lambertian surface which makes the laser spot visible outdoors and permits the trainer to be used in bright sunlight. The target board is quite weather resistant and may be left in place on the training field.

The Army and Marine Corps have purchased several hundred of these Tank Gunnery Trainers for teaching basic gunnery skills. They are in use at Fort Knox and in Europe. Because of the nonavailability of a protected gunnery range in the European locations, trainees receive their only refresher courses using the Tank Gunnery Trainer. The use of the laser in place of live ammunition reduces training costs, range maintenance, and weapon deterioration. Actual long-range cost savings have not yet been determined through systematic on-site test and evaluation.

1. Breglia, D., "Gas Lasers in Weapon Firing Simulators, IH-154," Naval Training Equipment Center, Orlando, Nov. 1968.
2. Mohon, N., Breglia, D., and Rodemann, A., U.S. Patent No. 3,916,536, "Direct Fire Weapon Simulation," 4 Nov. 1975.

TANK GUNNERY TRAINER

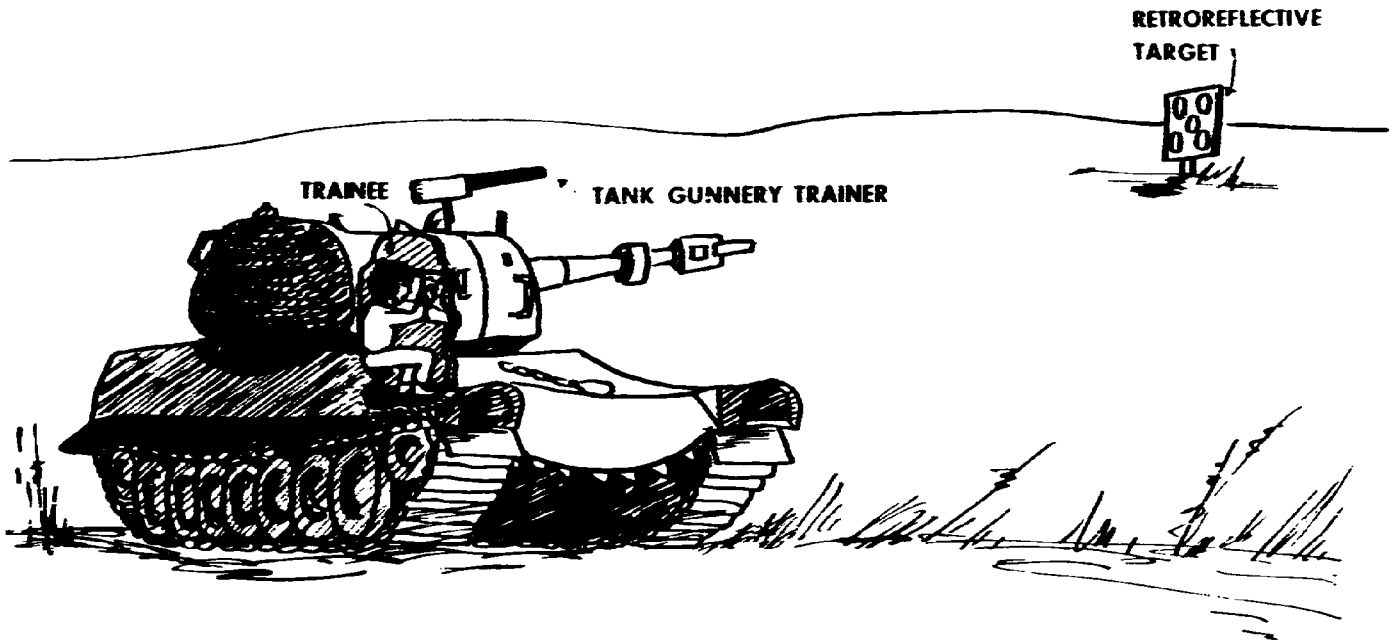

Figure 1. Tank Gunnery Trainer Deployed

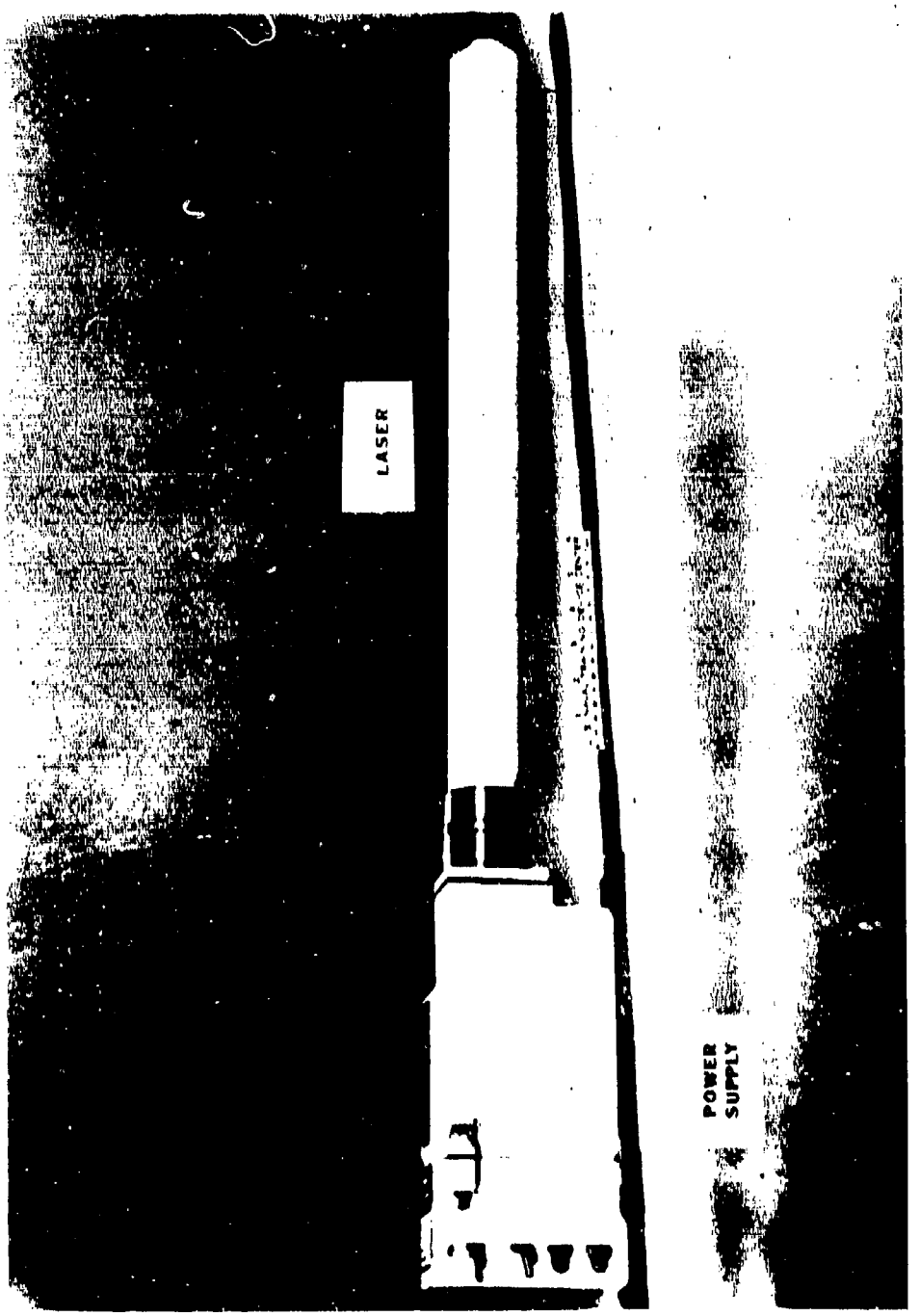

Figure 2. Tank Gunnery Trainer

SECTION III

ARTILLERY DIRECT FIRE TRAINER[3,4]

The Artillery Direct Fire Trainer is used to teach trainee gunners how to properly use a 155 millimeter howitzer (or other artillery piece) in its direct fire mode. The main mission of a howitzer is indirect fire; however, under dire circumstances, it sometimes becomes necessary to drop the weapon into a direct fire position. Since direct fire is a secondary mission, trainees were previously allowed to fire only two rounds per year in this mode of operation. Using the laser simulator, trainees may now fire several hundred rounds in one day and become quite proficient.

Each howitzer and direct fire trainer (see figure 3) has two gunners - one for lead, and one for elevation. These two gunners sit in their respective positions in an actual self-propelled howitzer and view through their normal sights. The trainer is mounted on the weapon. The remainder of the crew is in its place also. The gunners sight onto a scaled moving target board which is carried in a trailer being towed by a jeep. When the gunners are satisfied that they have properly positioned their weapon, a signal is given to a third trainee who pulls a lanyard cord activating a switch and turning on the laser device. A 100 millisecond burst of laser light images on the target board indicating a hit. There is a spill over area around the target per se which allows the trainees to see near misses of up to five meters. The target board is towed freely over a 10:1 scaled range allowing trainees nearly unlimited practice. Because the target motions are unprogrammed, trainees cannot memorize its movement and cheat on their score.

In order to save time and development costs, this simulator was constructed by merely modifying the Tank Gunnery Trainer described above. An adaption kit (see figure 4) was developed for mounting the Tank Gunnery Trainer directly in the muzzle brake of the howitzer. A mounting bracket was designed to fasten and boresight the laser in the muzzle of the howitzer. A deflection system including two micrometer driven mirrors was mounted at the front of the laser to direct its beam in directions exactly opposite of those required by the trainee gunner.

---

3. Ibid (See Reference 2 on page 4.)
4. Breglia, D., Mohon, N., and Mulson, J., U.S. Patent No. 3,788,733, "Laser Direct Fire Simulator Howitzer," 29 Jan. 1974.

ARTILLERY DIRECT FIRE TRAINER

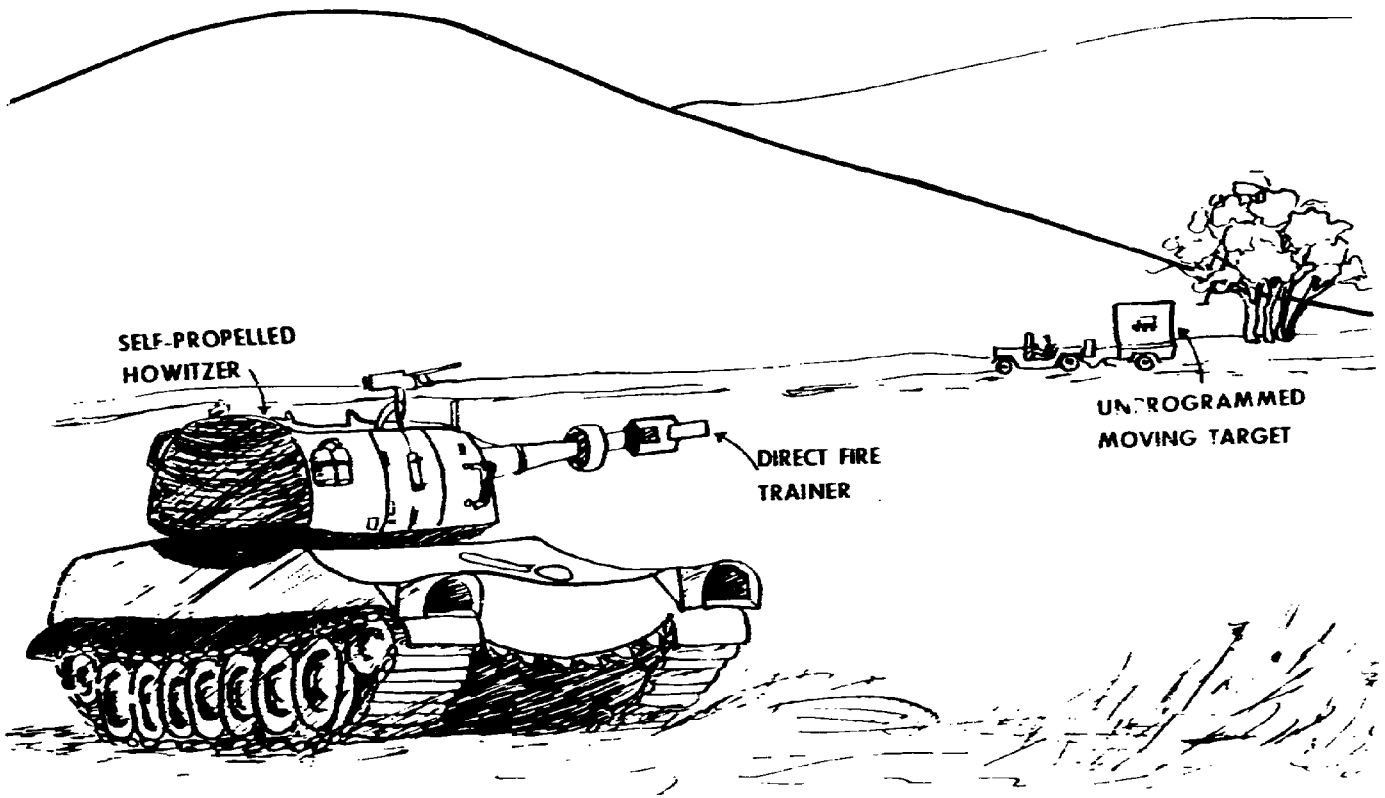

Figure 3. Artillery Direct Fire Trainer Deployed

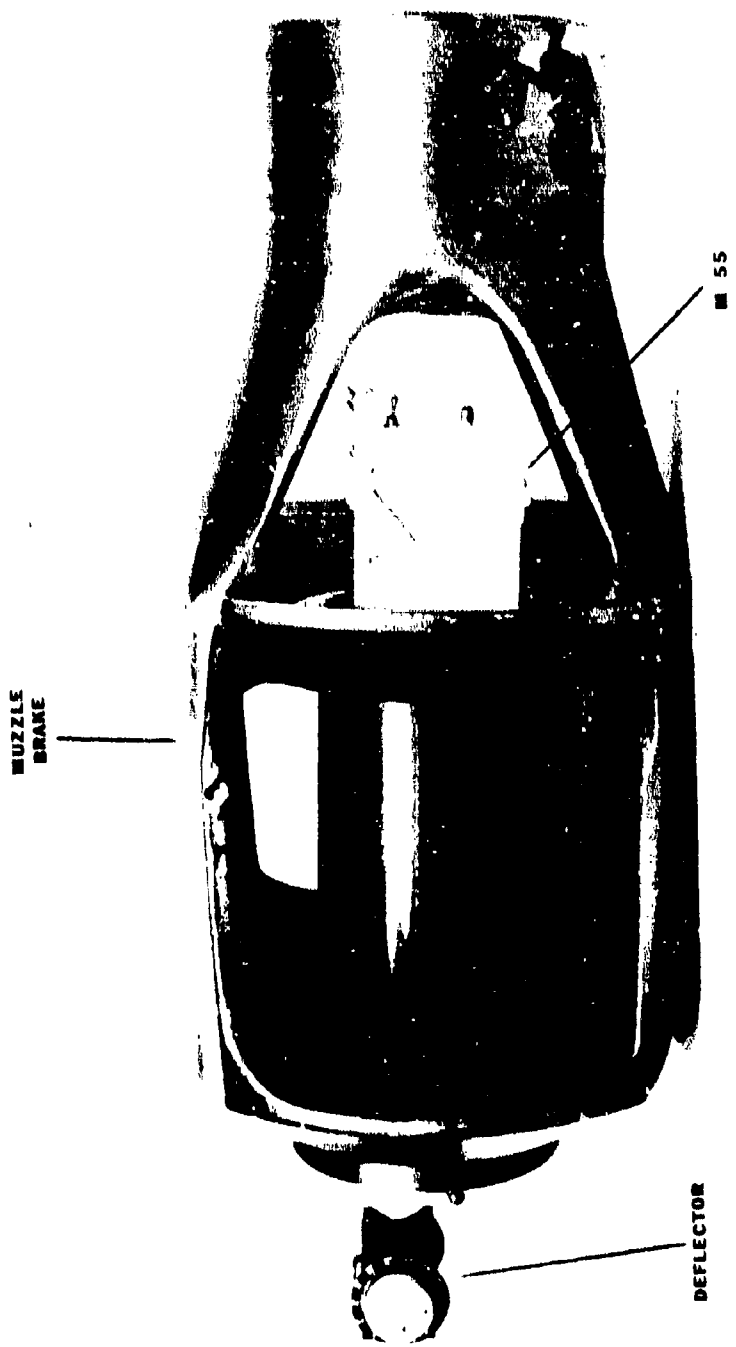

Figure 4. Artillery Direct Fire Trainer

The Artillery Direct Fire Trainer was evaluated at Fort Sill after controlled tests were conducted. One group of students was trained in the standard manner and served at the control group. A second group was trained using only the simulator. Then the two groups were placed in real howitzers and allowed to fire a specified number of rounds at certain ranges and were scored. The results indicated[5] that the laser trained group had 30% more hits at every range than the standard trained group. And the laser trained group acquired and fired on targets 5% faster than the control group. The concensus of the evaluators is that the laser trained group knew their weapon better and operated with more confidence. A new feature provided by the laser simulator which was not possible with old techniques is that a gunnery crew could continuously track a moving vehicle and fire on it several times, more efficiently thereby learning proper lead and elevation. A second new feature is that the weapon bore need not be cleaned after each training session.

5. Gunton, J. A. and Underwood, C. A., "Operational Test of Artillery Direct Fire Trainer," TRADOC 2-WE-223-ADF-601, Fort Sill, Dec. 1975.

SECTION IV

MACHINE GUN SIMULATOR[6]

The training concept for the Machine Gun Simulator is shown in figure 5. Two trainee gunners are appropriately positioned behind their M60 machine gun simulators in a classroom environment and are instructed to fire according to proper procedures and team tactics as if they were protecting a certain zone. Then a motion picture containing many targets is presented to the trainees on the screen across the room. The trainees then fire their weapon simulators at the movie scene in proper sequence and see bursts of laser light impinging on the screen at the cyclic rate of fire of the real weapon. An instructor standing nearby provides scoring, confidence, and corrective instruction.

The simulator is composed of (see figure 6) a laser module and a power supply. The laser module is mounted on the barrel of an M60 machine gun and contains a one milliwatt helium neon laser. A rotating slotted disk is placed in the optical path of the laser beam to modulate it at the rate of fire of the weapon. A second solenoid actuated shutter blocks the laser beam entirely until the trigger is depressed; and then, it moves from the optical path and passes the laser light. This device is eyesafe in accordance with the laser safety standard ANSI Z136.1-1976 due to the short bursts of laser light.

This device was developed for the Army for use in training infantrymen. It has been tested at Fort Benning, Georgia, and Fort Carson, Colorado; but has not yet received final approval for type classification and general issue.

6. Breglia, D., Rodemann, A., and Mohon, N., U.S. Patent No. 3,748,751, "Machine Gun Simulator," 31 July 1973.

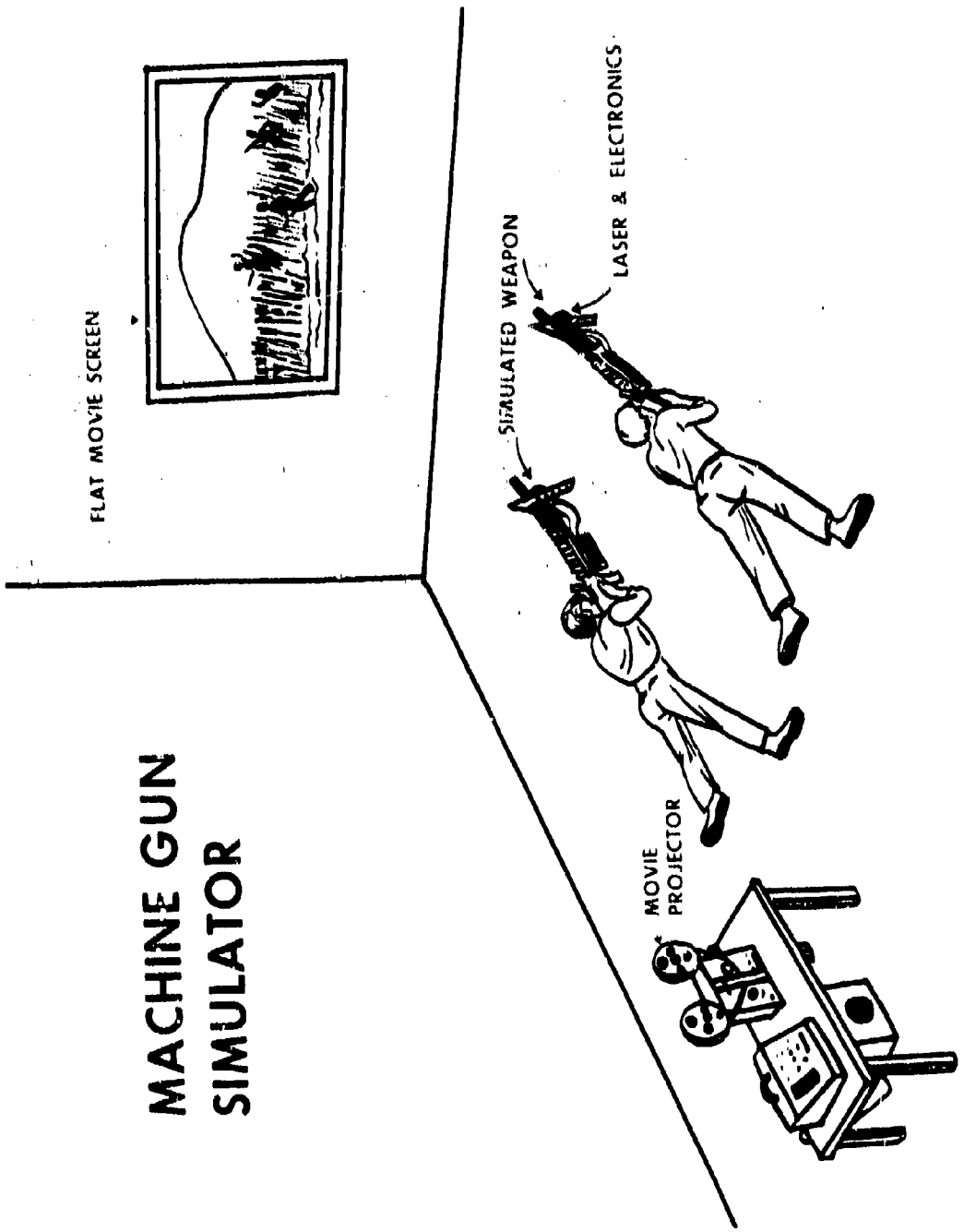

Figure 5. Machine Gun Simulator Deployed

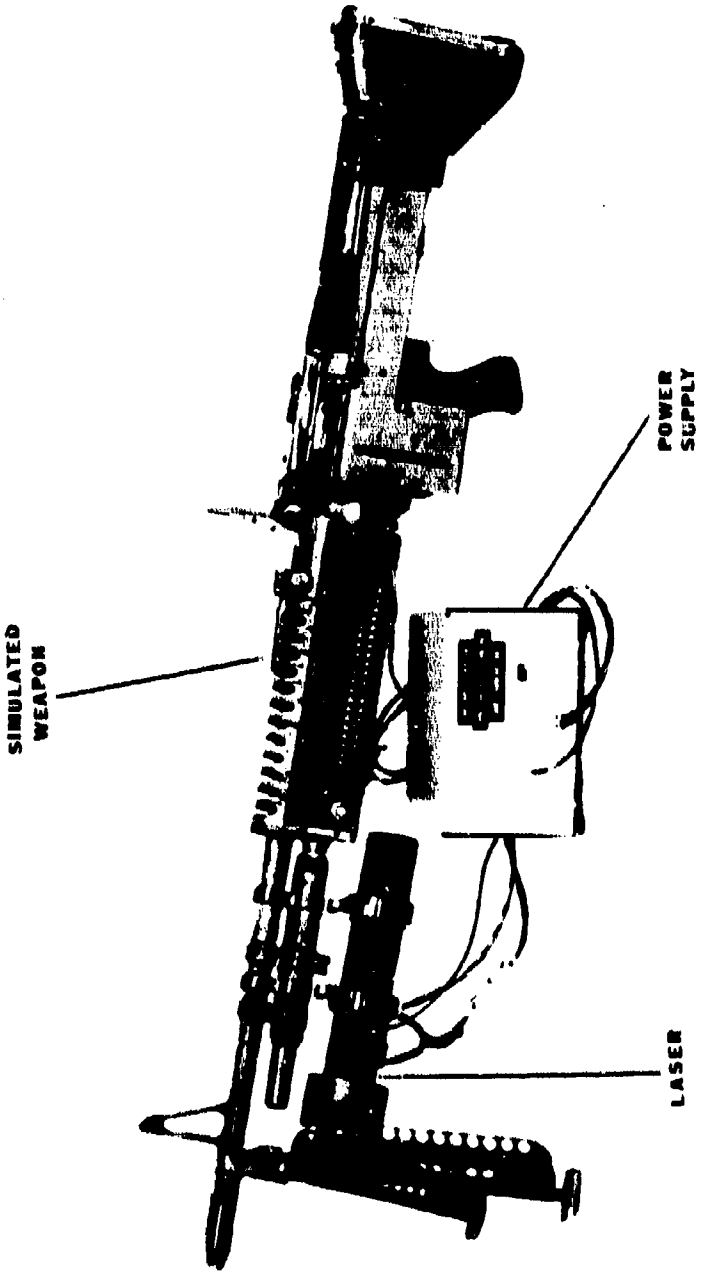

Figure 6. Machine Gun Simulator

SECTION V

HELICOPTER DOOR GUNNERY TRAINER[7,8]

In the Helicopter Door Gunnery Trainer a trainee is taught correct machine gun firing procedures from the door of a helicopter. The trainee stands (see figure 7) on a motion platform, which vibrates in a manner similar to a CH46 helicopter, and fires the laser weapon simulator against a 90° x 60° motion picture display containing background terrain and targets. He wears a helmet containing earphones that present the correct weapon sounds and other audio in response to his inputs. The trainer is presently designed for a rescue mission and so the trainee is taught defense type firing against the ground targets. The mission is changed by inserting a new movie film. The same mechanical methods are used for this machine gun simulator as the one described above.

The effectiveness and realism of the simulator were evaluated by a team of Marines who were experienced door gunners. The team gave the trainer an excellent rating and certified its usefulness in the training schools. It has received Marine Corps support; therefore, we will be producing an engineering development prototype for field tests.

7. Ibid (See Reference 6 on page 11.)
8. Breglia, D. and Rodemann, A., "Laser Helicopter Gunner Trainer," IH-261, Naval Training Equipment Center, Orlando, Jan. 1976.

LASER HELICOPTER GUNNER TRAINER

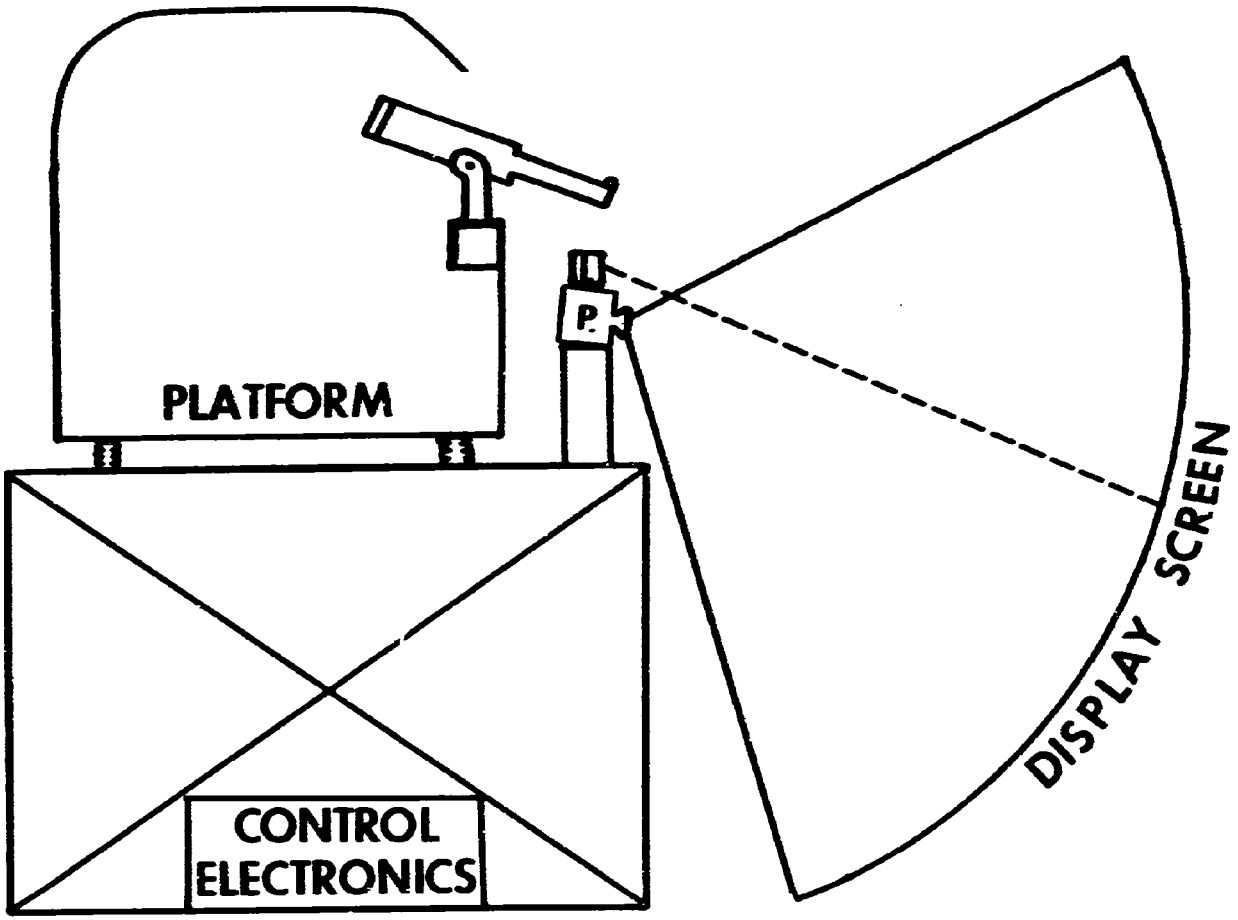

Figure 7. Laser Helicopter Gunner Trainer

REFERENCES

Breglia, D., "Gas Lasers in Weapon Firing Simulators, IH-154," Naval Training Equipment Center, Orlando, Nov. 1968.

Mohon, N., Breglia, D., and Rodemann, A., U.S. Patent No. 3,916,536, "Direct Fire Weapon Simulation," 4 Nov. 1975.

Breglia, D., Mohon, N., and Mulson, J., U.S. Patent No. 3,788,733, "Laser Direct Fire Simulator Howitzer," 29 Jan. 1974.

Gunton, J. A. and Underwood, C. A., "Operational Test of Artillery Direct Fire Trainer," TRADOC 2-WE-223-ADF-601, Fort Sill, Dec. 1975.

Breglia, D., Rodemann, A., and Mohon, N., U.S. Patent No. 3,748,751, "Machine Gun Simulator," 31 July 1973.

Breglia, D. and Rodemann, A., "Laser Helicopter Gunner Trainer," IH-261, Naval Training Equipment Center, Orlando, Jan. 1976.

NAVTRAEQUIPCEN IH-284

DISTRIBUTION LIST

Naval Training Equipment Center Orlando, FL 32813	120
Defense Documentation Center Cameron Station Alexandria, VA 22314	12